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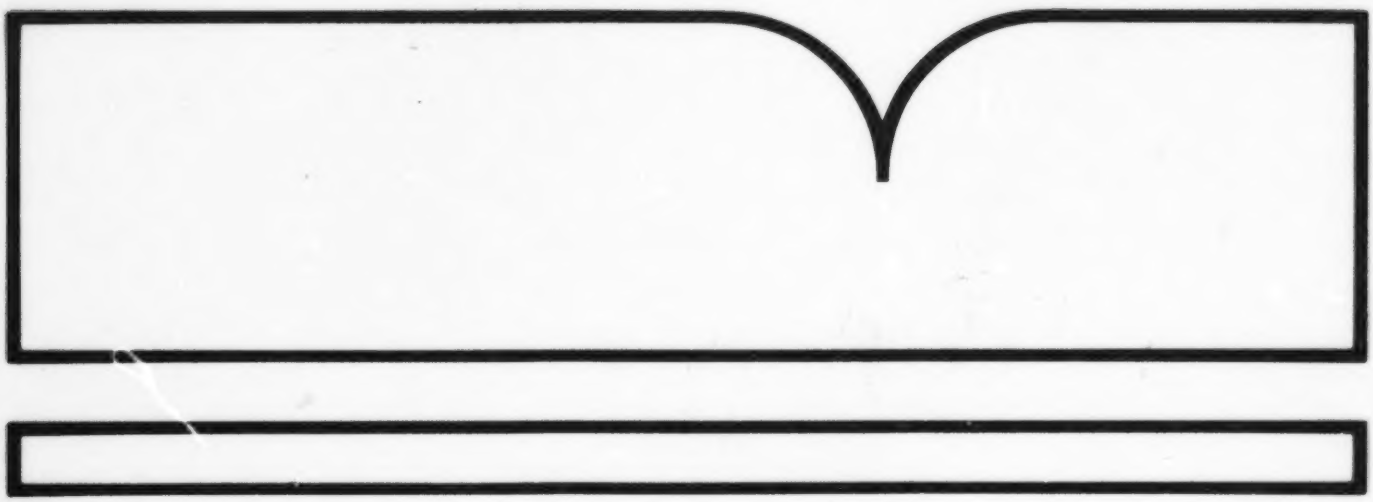

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16. ABSTRACT The Atlantic Silverside (*Menidia menidia*) is an abundant annual fish in Rhode Island, USA, waters and is being cultured in the Narragansett Laboratory of EPA for use in toxicological bioassays following culture techniques described by Beck (1977). It is desirable for laboratory-reared fish used in the bioassays to approximate the field-captured fish as closely as possible. Comparing growth of lab-reared fish with those in the field has been difficult. The relatively long spawning season in Rhode Island (late April through mid-July) results in large variation in size of field fish at any one time.

This study uses the otolith daily growth ring aging technique developed by Barkman (1978) to compare growth of *M.menidia* in lab and field populations and to examine growth of field fish hatched at different times. Field fish were found to have a much higher growth rate (0.84mm/d) than lab-reared fish (0.30mm/d). Even when fed *Artemia* nauplii equivalent to 100% of their body weight per day, lab-reared juvenile silversides grew at less than 0.5mm/d. Measurements of growth rates of field populations indicated that later-hatched fish are shorter in length at any given age (up to 50 days) than their early-hatched counterparts.

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DAILY GROWTH OF THE JUVENILE FISH (*MENIDIA MENIDIA*) IN THE NATURAL HABITAT COMPARED WITH JUVENILES REARED IN THE LABORATORY

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INTRODUCTION

The Atlantic silverside (*Menidia menidia*) is an abundant annual fish in Rhode Island, USA, waters which is being cultured in the Narragansett laboratory for use in toxicological bioassays following culture procedures described by Beck (1977).

It is desirable for laboratory-reared fish used in the bioassays to approximate the field-captured fish as closely as possible. Comparing growth of lab-reared fish with those in the field has been difficult. The relatively long spawning season in Rhode Island (late April through mid-July) results in large variation in size of field fish at any one time. In the past, it has not been possible to accurately age larval and juvenile fish in the field, but recently Barkman (1978) has found that young *M. menidia* can be aged using otolith daily growth rings.

This study uses the daily ring aging technique to compare growth of *M. menidia* in lab and field populations and to examine growth of field fish hatched at different times.

MATERIALS AND METHODS

Lab Culture: Gravid adult fish captured in the field were transported live to the lab and eggs were stripped and artificially fertilized. Incubation was in hatching jars (Barkman and Beck, 1976). After hatching, larvae were transferred to 0.41 m diameter plastic holding tubs and ultimately to 0.91 m diameter fiberglass tanks, each receiving a continuous flow of filtered ambient water. Water temperature varied from 17.0° to 22.5° C, salinity from 27 to 32 ‰. A 12L:12D light regime was maintained and fish were fed twice daily with *Artemia salina* nauplii, approximately 0.60 g per feeding. Samples of these fish were collected at periodic intervals. They were measured with a dial caliper, and patted dry. Wet weight was measured on an electric balance. The fish were from a single hatching and age in days was known.

Field Collection: Sampling of field fish was carried out at approximately biweekly intervals during 1977 using a 2-mm mesh beach seine. The area sampled was on the west shore of the Upper Pettaquamscutt River, a drowned river valley estuary which flows into Narragansett Bay. Fish were returned to the laboratory and total length and wet weight were measured and recorded in the same manner as the lab-cultured fish. The sagitta/otoliths were then removed, mounted in Euparal and rings were counted as described by Barkman (1978). The age of a fish was determined by using the ring count as the independent variable in Barkman's (1978) regression equation.

Data Analysis: Regression lines were calculated and analyses carried out using the LINES computer program at this laboratory (based on Snedecor and Cochran, 1967, pp. 432–436).

RESULTS AND DISCUSSION

Age-length regression lines for 105 laboratory-reared and 203 field-captured fish are shown in Figure 1. Equations for both lines are:

$$\text{Lab} \quad Y = 0.29511X + 5.49125 \quad (r^2 = 0.90263)$$
$$\text{Field} \quad Y = 0.84197X + 3.40942 \quad (r^2 = 0.88792)$$

where Y = total length in millimeters and X = age in days. Both slopes were significantly different from

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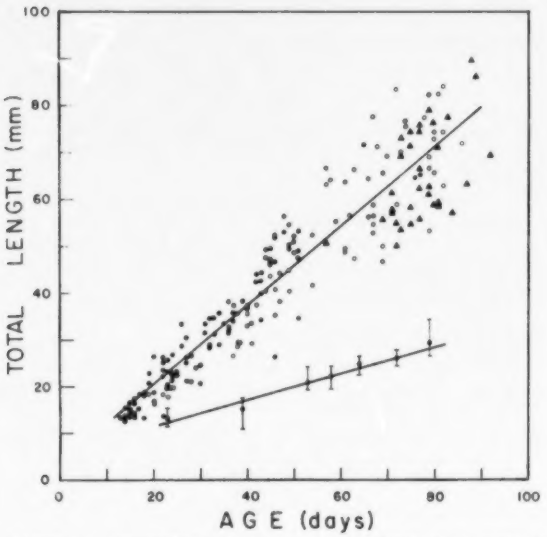

Figure 1. Comparison of lab versus field growth of *M. menidia*. The lower regression line represents lab growth, upper line field growth. Bars represent the range of sizes of laboratory-reared fish on a particular date with dots indicating mean size (data based on at least 10, and usually 20, fish per sample). Individual data points are for field-captured fish as follows: (•)-fish hatched from May 12 to May 31; (∘)-those hatched from June 1 to June 15; (▲)-those hatched after June 15. Regression equations given in text.

zero ($p < 0.0001$) and an analysis of covariance showed that the slope of the field regression line was significantly greater ($p < 0.0001$) than that for the lab.

Field fish, therefore, have a much higher growth rate (0.84 mm/d) than lab-reared fish (0.30 mm/d). Even in a 24-day experiment in which they received *Artemia* nauplii equivalent to 100% of their body weight per day, lab-reared juvenile silversides grew at less than 0.5 mm/d (Bengtson et al., 1978). Other aspects of lab culture which may limit growth (e.g., nutritional quality of *Artemia*, size of culture tank, water temperature, etc.) are currently being investigated.

From age and capture data, hatching date was calculated for each field fish. Figure 2 shows the frequency of hatch dates from May 12 to July 7 for the 203 field fish. These fish were arbitrarily divided by time into three groups: early (hatched before June 1), middle (hatched from June 1 to June 15), and late (hatched after June 15) hatching groups. Field fish were plotted according to hatch group in Figure 1. It is interesting that fish from the early-hatched group left the sampling site when they reached about 50 days of age and were eventually replaced by the late-hatched group which were 57 days or older before they entered

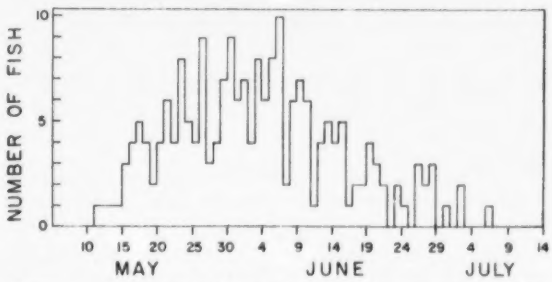

Figure 2. Histogram of the number of fish in our samples which were calculated to have hatched in the field on each date indicated on the abscissa.

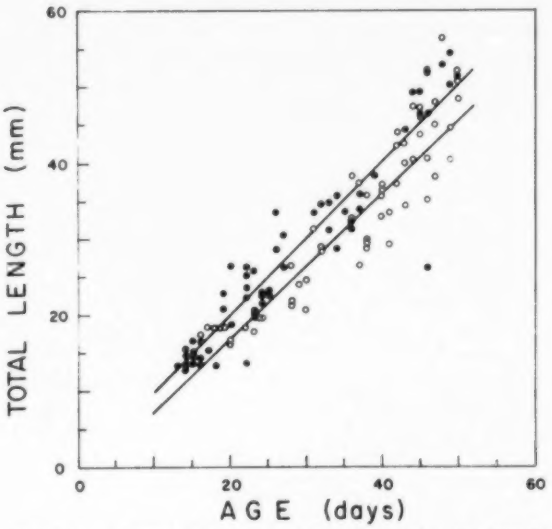

Figure 3. Comparison of fish (•) hatched from May 12 to May 28 (E-50) with that of fish (∘) hatched from May 29 to June 15 (L-50). Regression equations given in text.

the sampling area. These data, showing an apparent increase in mobility of *M. menidia* as they approach adult size, supports Buttner and Brattstrom's (1960) earlier study on movement of tagged adults.

Growth of earlier and later hatching fish was compared. Because early hatching fish left the area after 50 days of age, comparisons were limited to fish hatched between May 12 and June 15 and whose ages were less than 50 days. This subsample of 118 animals was divided equally into two groups: the early 50-percentile (E-50) group (hatched between May 12 and May 28) and the late 50-percentile (L-50) group (hatched between May 29 and June 15). Linear regressions of length on age were calculated and the

results are given in Figure 3. Equations were:

E-50 $Y = 1.01351X - 0.41281$ ($r^2 = 0.89104$)
L-50 $Y = 0.98984X - 2.79201$ ($r^2 = 0.83382$)

where Y = total length in millimeters and X = age in days. The slopes were significantly different from zero ($p < 0.0001$), but not from each other ($p > 0.05$). However, the E-50 intercept was significantiy greater ($p < 0.05$) than the L-50 intercept. That is, the L-50 regression line is parallel to, but lower than, the E-50 regression line, indicating that later-hatched fish are shorter in length at any given age (up to 50 days) than their early-hatched counterparts.

The technique of counting daily growth rings to age field-captured *M. menidia* has proven to be valuable. It has been possible thereby to compare lab versus field growth, and to gather data on the growth and movements of young-of-year fish. Studies are now underway to relate individual growth to changes in environmental variables.

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